

# A Pilot Urban Church-based Programme to Reduce Risk Factors for Diabetes Among Western Samoans in New Zealand

D. Simmons\*, C. Fleming, J. Voyle, F. Fou, S. Feo, B. Gatland

*The South Auckland Diabetes Project, South Auckland Academic Division, Middlemore Hospital, Auckland, New Zealand*

We have assessed the impact of a 2-year pilot church-base diabetes risk reduction programme on major lifestyle predictors of future Type 2 diabetes mellitus: exercise and weight control in a prospective non-randomized controlled study of a modular lifestyle and diabetes awareness intervention programme using a community development model. The study involved two complete church congregations from an ethnic group at high risk of diabetes (Western Samoans) (intervention church  $n=78$ ; control church  $n=144$ ). Weight remained stable ( $0 \pm 4.8$  kg) in the intervention church but increased by  $3.1 \pm 9.8$  kg in the control church ( $p=0.05$ ). In the intervention church, there was an associated reduction in waist circumference ( $-4 \pm 10$  cm vs  $+2 \pm 7$  cm in control,  $p < 0.001$ ), an increase in diabetes knowledge ( $46 \pm 26$  % vs  $4 \pm 17$  % in control,  $p < 0.001$ ) and an increase in the proportion exercising regularly ( $+22$  % vs  $-8$  % in control,  $p < 0.05$ ). Consumption of key fatty foods was also reduced in the intervention church. We conclude that diabetes risk reduction programmes based upon lifestyle change, diabetes awareness, and empowerment of high risk communities can significantly reduce risk factors for future Type 2 diabetes. © 1998 John Wiley & Sons, Ltd.

*Diabet. Med.* 15: 136–142 (1998)

**KEY WORDS** Type 2 diabetes mellitus; exercise; education; obesity; nutrition; community development

Received 1 May 1997; accepted 7 September 1997

## Introduction

There is increasing evidence that regular exercise and avoiding obesity will either delay or prevent the onset of Type 2 (non-insulin-dependent) diabetes mellitus.<sup>1</sup> These lifestyle changes are of particular importance among those ethnic groups, such as Western Samoans or Polynesians, who are at high risk of this type of diabetes.<sup>2</sup> While many Western Samoans continue to live in their Pacific Islands, a large number now live in Auckland (60 000). Migration has been associated with reduced access to traditional food<sup>3</sup> and less physically arduous employment. Furthermore, the village is no longer the basic unit in the urban setting. The church has become more than a religious institution. It is a social centre and focus of life for many Pacific Islands people.<sup>4</sup> In view of the importance of the church in the

lives of Pacific Islands people, it is a logical setting for introducing diabetes risk reduction programmes. Churches have already been used as foci for lifestyle programmes among African American communities.<sup>5</sup>

The South Auckland Diabetes Project (SADP) has been developing tools for the control of diabetes in South Auckland (population over 300 000), where one-third of the population are either Maori or of Pacific Islands descent. A diabetes knowledge and behaviour questionnaire (the DKB),<sup>6</sup> a diabetes education video,<sup>7</sup> and an integrated diabetes awareness/exercise programme<sup>8</sup> have been evaluated and validated among Pacific Islands people. We now describe a pilot study using these tools, the purpose of which was to evaluate the impact of a comprehensive diabetes related lifestyle programme on diabetes knowledge, exercise habits, dietary habits, and bodysize among a Samoan church congregation.

## Subjects and Methods

This was an open prospective study comparing lifestyle change in two complete Western Samoan church congregations in South Auckland. The congregations were similar in terms of denomination, socio-economic status and organization. They also had the same pastor.

Abbreviations: DKB a diabetes knowledge and behaviour questionnaire, SDA Seventh Day Adventist

\* Correspondence to: Dr David Simmons, Department of Medicine, Middlemore Hospital, Otahuhu, Auckland, New Zealand

Sponsors: The Lotteries Board; North Health; South Auckland Health; Tegal Boehringer-Mannheim; ASB Trust; Novo Nordisk; Eli Lilly; New Zealand Dairy Board and Sanitarium

## Selection of Intervention and Control Churches

A door-to-door survey of people known to have diabetes in South Auckland<sup>2</sup> demonstrated that four major church denominations are attended by local Pacific Islands people: Seventh Day Adventist (SDA), Catholic, Pacific Islands Congregational, and Latter Day Saints (unpublished data). SDA churches were considered suitable for the pilot of an integrated programme as they are relatively highly structured and have a Health and Temperance Committee. One of the door-to-door survey team (SF) was a member of the SDA church in the locality of the survey and invited us to start a diabetes risk reduction programme within her church. The pastor of the church was also responsible for another church approximately 3 km away and invited the SADP into the second church. The pastor accepted the second church as a control group for the study on the understanding that the second church would receive the intervention on completion of the pilot (this is now under way). Approval was also obtained from the elders and Health and Temperance Committees of the control and intervention churches. The study was approved by the North Health Ethics Committee.

## Assessment

Church members were identified by the pastor and Health and Temperance Committee, who also continuously encouraged congregants to participate in the programme. The programme started for both churches with baseline assessments between September and December 1993 and repeat assessments were completed in April 1996.

Congregants received a brief 5 minute presentation before the assessments. However, in order not to influence the assessments, specific information about diabetes was not included in the talk. A number of days for baseline and repeat assessments were announced at the end of church services. Subjects not attending were contacted and assessed in their own homes at a time convenient for them (including evenings and weekends). Subjects completed a DKB, which included open and closed diabetes knowledge (concerning the nature, symptoms, complications and treatment of diabetes) and exercise questions as previously described.<sup>6</sup> A seven item Fat Index was used including subjects' methods for cooking eggs, chops, and chicken (e.g. fry vs poach/boil), whether fat was cut off meat, whether skin was removed from chicken, whether a high or low fat spread was used (or neither) and the type of milk used (i.e. full fat vs semi-skimmed vs skimmed milk).<sup>6</sup> The proportion (out of 7) of high or medium fat items consumed was converted into a percentage. The DKB questionnaire is easy to administer and takes between 10 and 20 minutes to complete. Standard methodology was used to measure weight, height, minimum waist and maximum hip circumferences (three of each). At baseline, a venous

blood sample was taken and subjects with a 'positive screen' (either a random glucose  $\geq 6.0$  mmol L<sup>-1</sup> or a fructosamine  $\geq 260$   $\mu$ mol L<sup>-1</sup>) were referred for a 75 g oral glucose tolerance test (OGTT). Subjects with a 'positive screen' were repeatedly visited to encourage them to attend for OGTT and transport was provided. At the end of 2 years, the DKB, weight, waist and hip measurements were repeated in both churches. Blood tests were not repeated in order to maximize the response to the anthropometric assessments. Evaluation questions relating to participation, assessment of components (using a five point Likert scale in pictorial form ranging from very useful to not at all useful) and aspects of the programme that could be improved (using open questions) were added to the questionnaire for the intervention group.

## Interventions

The intervention programme was co-ordinated by a diabetes nurse specialist (CF) and one of two Samoan women (SF and FF). The Samoans were both members of the Health and Temperance Committee and one was the leader of the committee for 12 months. One Samoan (SF) was trained in diabetes fieldwork techniques and then as a community diabetes educator over a 12 month period before the programme began. The other woman (FF) was trained as an aerobics instructor. All training was certified and undertaken at local tertiary institutions.

'Networking', in the form of discussions with individual church leaders and members, continued throughout the intervention and ensured that the intervention remained culturally relevant. The results of the assessments were used to invite church members to a diabetes support group and to advise congregants of their risk factors for diabetes. Four diabetes awareness sessions were held as part of church services on a Saturday and included the use of leaflets (Samoan and English), a video made especially for Pacific Islands people<sup>7</sup> and flip charts with specially designed posters which were mainly in Samoa. The Samoan community diabetes educator was the main presenter at these sessions and also acted as an interpreter for the English speaking sections. The topics covered included the nature of diabetes, its symptoms, and long-term consequences if uncontrolled.

Following these diabetes awareness sessions, exercise groups were formed which included sitting exercises, low impact aerobics, walking, and sports. Sessions were held weekly for the first year and twice per week thereafter. The Samoan health worker who trained as an aerobics instructor led the exercise sessions with assistance from the church members involved. The exercise programme was supported by quarterly prize givings for the best attendance at the exercise sessions with a major prize at the end of the year. Reduced membership fees were negotiated with a local gymnasium. An application was made to a local trust which provided exercise equipment to be owned by the church.

Further practical assistance was given in the form of cooking demonstrations provided by staff from the SADP, local health promotion services and the wife of the minister (who was a home economics educator). Two blocks of four sessions were provided. The diabetes support group included informal diabetes community educator/nurse specialist sessions. The intervention church began participating in the national SDA annual 'Health Week' for the first time. This included a further diabetes awareness session and a cooking demonstration (carried out by the wife of the minister).

### Statistics

All analyses were performed using SPSS for Windows (SPSS Inc., IL, USA). All tests were 2-tailed with  $p < 0.05$  taken as significant. Discrete variables were compared using  $\chi^2$ . Continuous variables are shown as mean  $\pm$  standard deviation and are compared using one-way analysis of variance.

### Results

Both churches consisted totally of Western Samoans. Table 1 shows the response to the baseline and repeat assessments after 2 years in the intervention and control churches. First assessments were carried out within 2 months among 75 % of intervention subjects and 73 % of control subjects. Subjects with and without repeat assessments were similar with regards to baseline age, sex, anthropometric measurements, dietary and diabetes knowledge measurements.

### Measures of the Process

The response to the completion of the first questionnaire was similar in the two churches. The response to the second questionnaire among those who were either new to the church or had previously refused to complete a questionnaire was higher in the intervention church (15/15 vs 12/20,  $p < 0.05$ ). Table 2 compares the demographic characteristics between the two churches. While the response to screening was similar, fewer of those with a positive screen went on to OGTT in the

control group than was the case with the intervention group (15 % vs 67 %,  $p < 0.01$ ). Three diabetic subjects from the intervention church and one from the control church moved away from the church to an unknown address during the study period.

Table 3 shows the participation rates and usefulness score for each component of the programme. Figure 1 shows the attendance at the exercise group by quarter. Among those completing the second assessments, 99 % of subjects indicated that the programme helped them cope better and all subjects were either very satisfied (68 %) or satisfied (32 %) with the programme. None of the components of the programme was reported as either 'not very useful' or 'not at all useful'. Screening for diabetes, blood pressure, and anthropometric measurements were reported as useful or very useful by 93–97 % of subjects. Even the study assessment forms (DKB questionnaire) were found to be useful or very useful by 64 %. Participation in the cooking sessions was significantly greater among women than men (50 % vs 19 %,  $p < 0.05$ ). Participation rates for all other components were similar between the sexes except for the diabetes support group, which was attended by 1 (non-diabetic) male (5 %) but 11 (32 %) females ( $p = 0.01$ ). The diabetes support group was attended by 3 of the 4 remaining diabetic congregants, the other attenders being their friends or relatives. The small number of diabetic subjects made the group unsustainable.

### Changes in Measures of Anthropometry, Diabetes Knowledge, Fat intake and Exercise

Tables 4 and 5 compare the prospective data (i.e. those with both first and second assessments) in the two churches. The data for the intervention church show no weight gain, a decrease in waist circumference, increased diabetes knowledge, increased exercise activities and reduced reported dietary fat intake in the intervention church. Although these were SDA churches which have a vegetarian philosophy, over all subjects, chops were reported to be eaten by 88 %, and chicken by 94 % of subjects (no differences between the churches).

Table 1. Participation rates in the study

	Intervention	Control	Significance
Member at time of first assessment	78	144	
First assessment	67 (86 %)	115 (80 %)	ns
Refused	8	1	
Did not attend	3	28	
Moved, died, overseas by time of second assessment (proportion of those with first assessment)	15/67 (22 %)	22/115 (19 %)	ns
Second assessment (response)	50/52 (96 %)	92/93 (99 %)	ns

Table 2. Baseline characteristics

	Intervention ( <i>n</i> = 67)	Control ( <i>n</i> = 115)
Age (yr)	37 ± 16	35 ± 17
Age range (yr)	14–80	14–102
% Female	66 %	61 %
Speak only Samoan at home	68 %	70 %
Educated to secondary school or above	74 %	79 %
Smokers	3 %	3 %
Height (cm)	164 ± 8	165 ± 9
Known diabetes (%)	7 (10 %)	3 (3 %)
Screened	45/60 (75 %)	89/112 (79 %)
Screen positive <sup>a</sup>	12 (27 %)	26 (29 %)
Attended OGTT (diabetes, IGT)	8 (0,2)	4 (1,0)
New diabetes <sup>b</sup> screened	0/45 (0 %)	5/89 (6 %)

<sup>a</sup>Those with a glucose ≥ 6.0 or a fructosamine ≥ 260 μmol L<sup>-1</sup>: all invited to OGTT.

<sup>b</sup>New diabetes: 3 with random glucose above 11.1 mmol L<sup>-1</sup> and fructosamine above 300 μmol L<sup>-1</sup>; 2 with fructosamine above 300 μmol L<sup>-1</sup> but glucose < 11.1 mmol L<sup>-1</sup>. Values shown are mean ± SD.

Table 3. Self reported participation rates of components of the intervention church programme

	Participation ( <i>n</i> = 55) <sup>a</sup>	Usefulness <sup>b</sup>
Introductory talk	93 % (51)	2.4 ± 0.8
Receiving results to tests	95 % (52)	1.2 ± 0.5
Diabetes awareness	98 % (54)	1.1 ± 0.5
Advice about weight, healthy food and exercise	96 % (53)	1.1 ± 0.3
Video session	18 % (10)	1.3 ± 0.7
Food/cooking sessions	38 % (21)	1.5 ± 0.8
Exercise sessions	84 % (46)	1.1 ± 0.4
Diabetes Support Group	22 % (12)	1.3 ± 0.8
Overall Church results presentation	91 % (50)	1.8 ± 0.9

<sup>a</sup>Includes those assessed first and second times (*n* = 50) and those refusing first time but completing questionnaire second time.

<sup>b</sup>Among those attending: 1 = very useful, 2 = useful, 3 = OK, 4 = not very useful, 5 = not at all useful. No subjects reported a 4 or 5 for any component. Values shown are mean ± SD.

## Discussion

This was a difficult study to undertake. The control group were disappointed that they were not to receive the intervention and started their own exercise programme which subsequently ceased to function. Their role as a control group was probably reflected in their reluctance to attend for OGTT (in spite of frequent urging to attend) and the lower proportion of subjects who had previously refused or who were new to the church completing a second DKB questionnaire. While response rates among those staying in the church were high, this level was only achieved with multiple home visits. The extensive mobility into and away from the study population was also a handicap to the study. While this mobility was expected,<sup>9</sup> it did result in numbers being too small to assess the impact of the programme on those with diabetes. The mobility also produced problems with analysis, although the prospective data should be rep-

resentative of those who remained resident. Those moving away were similar to those remaining.

In spite of these caveats, the reduction in waist circumference and lack of increase in weight over a 2-year period is an exciting result. No previous population-based lifestyle programmes identified through an extensive literature search have achieved such results.<sup>10,11</sup> The success of the members of the intervention church in maintaining their weight in contrast to the 3 kg weight gain in the control church could be associated with a significant reduction in the incidence of Type 2 diabetes.<sup>12–14</sup> The 22 % increase in subjects exercising regularly could also be associated with an estimated 8 % reduction in new cases.<sup>15</sup> The differences in change in anthropometry were also associated with significant reductions in reported fat intake in the intervention group, which did not occur in the control group. While habits relating to cutting the fat off meat were improved, the other differences in fat intake were mainly due to

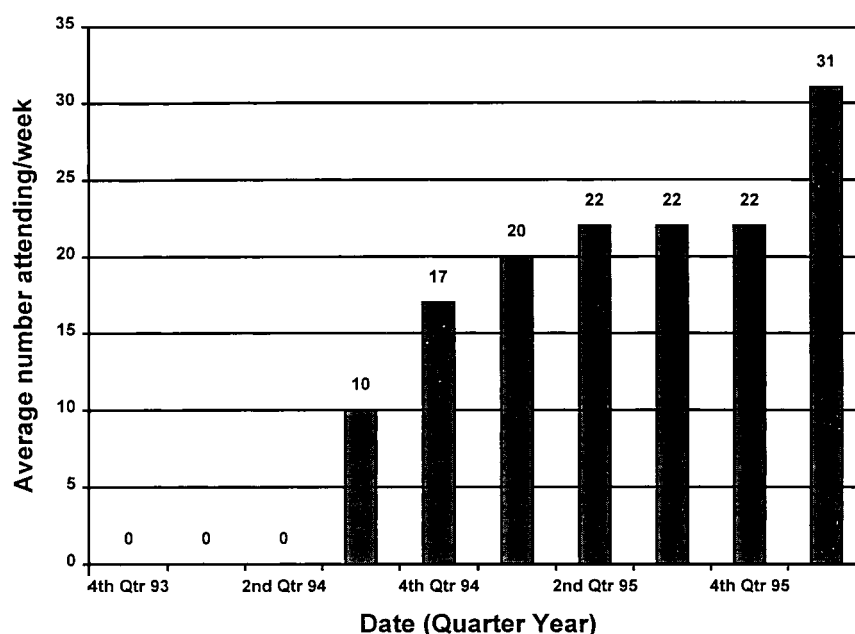


Figure 1. Attendance at the exercise group by quarter ( $n$  = average number attending per week). The total number of congregants varied during the time, but would have been between 70 and 78

Table 4. Diabetes knowledge and anthropometric measures at baseline and after 2 years in intervention and control groups

	Intervention church ( $n = 50$ )		Control church ( $n = 92$ )		Difference Intervention	Control	Significance of difference
	0	2 yr	0	2 yr			
Weight (kg)	83.6 $\pm$ 15.4	83.7 $\pm$ 14.4	87.7 $\pm$ 19.9	90.8 $\pm$ 20.9 <sup>a</sup>	0 $\pm$ 4.8	3.1 $\pm$ 9.8	$p = 0.05$
BMI (kg m <sup>-2</sup> )	31.2 $\pm$ 5.7	31.2 $\pm$ 5.3	32.1 $\pm$ 7.5	33.2 $\pm$ 7.7	0 $\pm$ 1.8	1.1 $\pm$ 3.6	$p = 0.06$
Waist (cm)	95 $\pm$ 13	92 $\pm$ 12	91 $\pm$ 17	94 $\pm$ 17	-4 $\pm$ 10	+2 $\pm$ 7	$p < 0.001$
Hip (cm)	110 $\pm$ 11	105 $\pm$ 13	110 $\pm$ 15	111 $\pm$ 15 <sup>a</sup>	-5 $\pm$ 9	+1 $\pm$ 5	$p < 0.001$
Waist:hip ratio	0.87 $\pm$ 0.08	0.88 $\pm$ 0.07	0.83 $\pm$ 0.08 <sup>b</sup>	0.84 $\pm$ 0.09	0.01 $\pm$ 0.07	0.02 $\pm$ 0.06	ns
Open knowledge Score (%)	19 $\pm$ 22	64 $\pm$ 19	16 $\pm$ 19	20 $\pm$ 22 <sup>c</sup>	+46 $\pm$ 26	+4 $\pm$ 17	$p < 0.001$
Closed knowledge Score (%)	50 $\pm$ 18	63 $\pm$ 17	47 $\pm$ 17	50 $\pm$ 23 <sup>c</sup>	+12 $\pm$ 24	+3 $\pm$ 22	$p < 0.05$

<sup>a</sup> $p < 0.05$ ; <sup>b</sup> $p < 0.01$ ; <sup>c</sup> $p < 0.001$ ; intervention vs control within second assessments. Values shown are mean  $\pm$  SD.

increased fat intake in the control group. It is likely (but unproven) that the increased knowledge of both diabetes and nutrition among the intervention group contributed to the sustainability of these changes. Although these were SDA churches, the majority were not vegetarians and this allowed many of the lifestyle changes to be successfully targeted.

In spite of the similar body mass indices between the two churches, they differed in a number of respects. At baseline, the control church population had a smaller waist circumference (not due to differences in sex ratio) and exercised more often than those in the intervention church. The reason for this is unknown. The same team, using the same methods, at the same time (the end of the New Zealand winter/early summer (September–December)) made the measurements and hence it is unlikely that seasonal or systematic bias occurred. The team were not intentionally blinded to subjects'

membership of either the intervention or control church, but it is unlikely that a team of 8 would consistently influence results in this way and to this degree.

We believe that the anthropometric measurements provide objective confirmation of the veracity of the food frequency and exercise self reports. In many ways, a quasi-experimental model, incorporating other objective measures, such as fasting glucose and lipids would have been preferable, to determine if the anthropometric measurements were associated with improvement in metabolic parameters. A further weakness of the evaluation is that it is a comparison of two similar churches, with the intervention church chosen for pragmatic reasons. However, such assessments may have been too intrusive and reduced the response rate. The main purpose of this study was to demonstrate that lifestyle control programmes could be successfully undertaken and could be sustainable among Pacific Islands



Table 5. Exercise and dietary measures at baseline and after 2 years in intervention and control groups

	Intervention church		Control church		Difference intervention	Control	Significance of difference
	0	2 yr	0	2 yr			
Exercise (days week <sup>-1</sup> )	2.0 ± 2.0	2.5 ± 2.0	2.5 ± 2.0 <sup>a</sup>	2.0 ± 2.0	+0.5 ± 2.5	-0.5 ± 2.4	<i>p</i> < 0.05
Exercising 3+ days week <sup>-1</sup>	33 %	55 %	48 %	40 %	+22 %	-8 %	<i>p</i> < 0.05
Stopping exercising					10 %	24 %	Overall <i>p</i> < 0.05
Starting exercise					31 %	15 %	
No change in exercise pattern					59 %	61 %	
7 item Fat Score (%)	77 ± 17	64 ± 22	72 ± 21	76 ± 23 <sup>b</sup>	-14 ± 28	+3 ± 24	<i>p</i> < 0.01
High fat preparation							
Milk	73 %	68 %	71 %	74 %	-5 %	+6 %	<i>p</i> < 0.05
Eggs	70 %	63 %	67 %	82 %	-7 %	+19 %	<i>p</i> < 0.01
Chops	64 %	63 %	70 %	84 %	-1 %	+14 %	<i>p</i> < 0.01
Chicken	81 %	60 %	74 %	85 %	-21 %	+11 %	<i>p</i> = 0.001
Spread	98 %	100 %	99 %	95 %	+2 %	+4 %	ns
Do not cut fat off meat	53 %	6 %	45 %	38 %	-47 %	-7 %	<i>p</i> < 0.001
Do not cut skin off chicken	85 %	76 %	77 %	73 %	-9 %	-4 %	ns

<sup>a</sup>*p* < 0.05; <sup>b</sup>*p* < 0.01; <sup>c</sup>*p* < 0.001; intervention vs control within second assessments. Values shown are mean ± SD.

people. A further weakness of the evaluation is that it was not a truly randomized study. The control group could not be isolated from general community-wide health promotion messages from our own study or nationally,<sup>16</sup> which may have reduced our ability to detect benefit from our programme. We are developing a district diabetes monitoring system to monitor local trends in the prevalence of diabetes.<sup>17</sup> Components of the monitoring system are already in place and will be combined with local health data.<sup>2,18</sup>

Pacific Islands leaders in New Zealand are increasingly recognizing diabetes as a priority health issue for their community. The initial suggestion to commence the study came from Pacific Islands people working with the South Auckland Diabetes Project, particularly the local Pacific Islands cultural advisor. However, the initiative itself came from within the predominantly European research/clinical community, supported and stimulated by the Pacific Islands people who were members of the study team. Adopting an empowerment model,<sup>19</sup> a partnership was formed with local church leaders, and with their help and support, church congregants. A guiding principle was that the intervention should impart necessary knowledge and skills to the church community so that they could assume control over the programme, with the research group serving in a resource capacity. A successful outcome of the study was that this was what eventuated, albeit in a gradual manner. The intervention church now plans and runs its own nutrition and exercise programme and has applied successfully to a charitable trust for funds to purchase exercise equipment. An empowerment model is presently guiding the implementation of the diabetes risk reduction programme in the control church to facilitate a similar process of church members assuming ownership.

In conclusion, this pilot study has demonstrated that the methods used sustainably increase diabetes

knowledge and exercise habits, reduce waist circumference, control weight, and alter dietary fat consumption. Since the completion of this pilot study, the programme has been extended to a further nine churches with predominantly Pacific Islands congregations. Early indications suggest that for most of these churches, our programme is attracting congregants and the methods developed are likely to reproduce the success in our pilot study. In view of the fact that the context of this study was created in a cultural milieu where the intervention has been provided largely by the community, it is reasonable to expect the programme to be sustainable over time.

### Acknowledgements

We are particularly indebted to Christina Tapu, the South Auckland Health Pacific Islands cultural adviser for her guidance. We are grateful to the Lotteries Board, North Health, South Auckland Health, Boehringer Mannheim, ASB Trust, Novo Nordisk, Eli Lilly, Tegal, New Zealand Dairy Board and Sanitarium for their material support. We thank Pastor Dr Erika Puni, Professor Sir John Scott, Pastor Laumua and Mrs Marisa Tunufa for their contributions, other members of the South Auckland Diabetes Project team for their hard work and the congregants of the two churches for their participation.

### References

1. Knowler WC, Narayan KMV, Hanson RL, Nelson RG, Bennett PH, Tuomilehto J, *et al.* Preventing non-insulin dependent diabetes. *Diabetes* 1995; **44**: 481-487.
2. Simmons D, Gatland BA, Leake L, Fleming C. Frequency of diabetes in family members of diabetic probands. *J Int Med* 1995; **237**: 315-321.

3. Bindon JR. Breadfruit, banana, beef and beer: modernization of the Samoan diet. *Ecology of Food and Nutrition* 1982; **12**: 49–60.
4. Macpherson C. *Emerging Pluralism. The Samoan Community in Urban New Zealand*. Auckland: Longman Paul, 1974.
5. Kumanyika SK, Charleston JB. Lose weight and win: a church based weight loss program for blood pressure control among black women. *Patient Education and Counseling* 1992; **19**: 19–32.
6. Mandell C, Simmons D, Fleming C, Leakehe L, Gatland B. Validation of a diabetes knowledge and behaviour questionnaire. *Asia Pac J Clin Nut* 1994; **3**: 193–200.
7. Fleming C, Simmons D, Leakehe L, Voyle J. Ethnic differences in the preception of a video developed for a multiethnic diabetes prevention programme in South Auckland, New Zealand. *Diabetic Med* 1995; **12**: 701–707.
8. Simmons D, Fleming C, Cameron M. Evaluation of a diabetes and exercise programme in a multiethnic work force. *NZ Med J* 1996; **109**: 373–376.
9. Simmons D, Gatland B, Leakehe L, Fleming C, Scragg R. Known diabetes in a multiethnic area. *NZ Med J* 1994; **107**: 219–222.
10. Jeffrey RW. Minnesota studies on community based approaches to weight loss and control. *Am J Coll Phys* 1993; **119**: 719–721.
11. Dowse GK, Gareeboo H, Alberti KGMM, Zimmet P, Tuomilehto J, Purran A, *et al.* Changes in population cholesterol concentrations and other cardiovascular risk factors levels after five years of the non-communicable disease intervention programme in Mauritius. *Br Med J* 1995; **311**: 1255–1259.
12. Hanson RL, Narayan KMV, McCance DR, Pettitt DJ, Jacobsson LTH, Bennett PH, Knowler WC. Rate of weight gain, weight fluctuation and incidence of NIDDM. *Diabetes* 1995; **44**: 261–266.
13. Colditz GA, Willett WC, Rotnizky A, Manson JE. Weight gain as a risk factor for clinical diabetes in women. *Ann Int Med* 1995; **122**: 481–486.
14. Sowers JR. Modest weight gain and the development of diabetes: another perspective. *Ann Int Med* 1995; **122**: 548–549.
15. Manson JE, Spelsberg A. Primary prevention of non-insulin dependent diabetes mellitus. *Am J Prev Med* 1994; **10**: 172–184.
16. Public Health group. *Issues Around a National Plan of Action for Diabetes*. Wellington: Ministry of Health, 1996.
17. Simmons D, Fleming C, Innes J, Cutfield R, Patel A, Wellingham J. Development of a process for diabetes audit in Auckland. *NZ Med J* 1997; **110**: 48–50.
18. Wilson P, Simmons D. The development of a community orientated plan for diabetes in South Auckland. *NZ Med J* 1994; **107**: 456–459.
19. Kieffer CH. Citizen empowerment: a developmental perspective. *Prevention in Human Services* 1984; **3**: 9–36.